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### RESEARCH ARTICLE

## COMPARISON OF THE EFFECT OF ULTRASOUND VERSUS LASER ON PAIN AND FUNCTION IN SUBJECTS WITH OSTEOARTHRITIS KNEE

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#### Abstract

**Background:** Osteoarthritis(OA) is a degenerative joint disease which leads to loss of hyaline articular cartilage associated with underlying bony changes. Knee osteoarthritis(KOA) is associated with pain and functional impairment which negatively affects the patient's quality of life. Ultrasound and LASER have been found effective in KOA but studies comparing the two are less.

**Method:** An experimental study was conducted with 21 patients of unilateral KOA randomized into three groups. Each group had 7 patients. Group A- Ultrasound- 1MHz, Pulsed 1:1, 0.8W/cm<sup>2</sup>, 10 min on medial knee joint line. Group B- LASER- 7.6J for 1 min and 30 sec for each trigger point. Group C- Conventional physiotherapy. All subjects received conventional physical therapy with hot packs and quadriceps exercise of affected knee. Outcome measures used were Numerical pain rating scale(NPRS), Sit to stand(STS) and Timed up and go test(TUG).

**Result:** Using Wilcoxon test, mean difference in pain in Group A(W=-2.414, p=0.016), Group B(W=-2.460, p=0.014), Group C(W=-2.392, p=0.017). Mean difference in STS in Group A(W=-2.392, p=0.017), Group B(W=-2.392, p=0.017), Group C(W=-2.428, p=0.015). Mean difference in TUG, Group A(W=-2.366, p=0.018), Group B(W=-2.371, p=0.018), Group C(W=-2.375, p=0.018). Applying Kruskal-Wallis test, mean difference between the groups, for pain(KW=6.612, p=0.037), STS(KW=3.020, p=0.221) and TUG(KW=7.822, p=0.020). Applying Bonferroni's post hoc test mean difference in pain between groups A and B was statistically significant(p=0.03), and mean difference in TUG between groups B and C was statistically significant(p=0.013).

**Conclusion:** Ultrasound, LASER and conventional physiotherapy are effective in reducing pain, improving function and mobility in subjects with OA knee. LASER is more effective than ultrasound and conventional PT for pain and more effective than conventional PT for mobility.

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**Introduction:-**

Osteoarthritis (OA) is a degenerative joint disease with pathological characteristics which leads to loss of hyaline articular cartilage associated with underlying bony changes. The main symptom of OA is pain, which increases with joint use and is relieved by resting.<sup>[1]</sup> Knee osteoarthritis (KOA) is one of the most debilitating conditions associated with pain and functional impairment which negatively affects the patient's quality of life.

The Osteoarthritis Research Society International (OARSI) published consensus recommendations from experts based on evidence to treat knee OA, which includes several modalities of non-pharmacological, pharmacological and surgical interventions for OA.<sup>[2]</sup> LASER i.e. Light Amplification by stimulated emission of radiation and ultrasound (US) both have been used in the treatment of OA knee.

Various studies have shown the positive effects of LASER therapy with hot packs and knee exercises to treat knee OA and clinical trials in humans. In parallel, therapeutic ultrasound (US) with hot packs and knee exercises has also shown positive effects on knee OA treatment. The main positive effects of these modalities are, for example, anabolic effects on cartilage,<sup>[3]</sup> anti-inflammatory action,<sup>[4]</sup> analgesia associated with muscle relaxation<sup>[5]</sup> and improvements in microcirculation.<sup>[6]</sup>

Therapeutic exercises (TE) reduce joint pain and enhance physical function in people with knee OA.<sup>[7]</sup> A literature review shows that TE is associated with Laser therapy<sup>[3]</sup> or US to treat knee OA.<sup>[3]</sup> The idea in these cases is that Laser therapy and US could alleviate delayed onset muscle soreness or joint pain post-exercise<sup>[8]</sup> and increase adherence to exercise, leading to improved health and functional status.

Numerical Pain Rating Scale (NPRS) is a scale to measure the intensity of pain. Sit to Stand (STS) is used as a measure of indicator of postural control, fall risk, lower limb strength and proprioception and overall function. Timed up and go test (TUG) is used to assess the patients mobility, dynamic and static balance. These were used as outcome measures in the study.

Studies have shown positive results when Laser is associated with exercises. Montes et al. showed that LLLT, in conjunction with quadriceps exercises, is a safe and effective treatment to reduce knee OA pain. A systematic review showed that when Laser therapy is applied before exercise, ergogenic and protective effects occur on skeletal muscle.<sup>[9]</sup> In the same way, therapeutic US could enhance the effectiveness of isokinetic exercise, improving functional outcomes among subjects with knee osteoarthritis.<sup>[10]</sup>

In this study, all subjects received conventional physical therapy with individual group receiving Laser therapy or US and hot packs, quadriceps exercise of affected knees. The aim of the study was to see the effect of LASER, Ultrasound, and conventional physiotherapy in subject of OA knee on pain using Numerical Pain Rating Scale (NPRS), on function using Sit To Stand (STS) and on mobility using Timed Up and Go (TUG) test. The aim was also to compare the effect of LASER, Ultrasound and Hot packs on Numerical Pain Rating Scale (NPRS), Sit To Stand (STS) and Timed Up and Go (TUG) tests.

**Method:-**

A randomized trial was conducted at college of physiotherapy. Permission to conduct the study was obtained from the head of the department. Total 21 subjects having osteoarthritis of the knee were included. Subjects above 50 years of age with medial knee joint line joint tenderness with grade 2 and 3 were included in the study. The subjects needed X-ray showing the changes of osteoarthritis of the knee with grade 2 and above of Kellgren and Lawrence grading. The exclusion criteria for the research were presence of inflammation at knee joint, increase in the skin temperature of affected knee and any previous psychological and cardiovascular condition. Thirty subjects were screened of which 21 were eligible. The participants were explained about the study and written informed consent to participate was obtained. Details regarding demographic data and the outcome measures were obtained from each participant. They are randomly allocated in three groups.

Group A was given Ultrasound with the dose of, 1 MHz, Pulsed 1:1, 0.8W/cm<sup>2</sup>, for 10 min<sup>[11]</sup> on medial knee joint line. Group B was given LASER with the dose of 7.6 J for 1 min and 30 sec for each trigger point<sup>[11]</sup>. Group C was given Hot Packs to knee for 20 minutes. In addition, all subjects received conventional physical therapy with hot packs and quadriceps exercise of affected knee for 5 days daily.

The measurement of NPRS is done by asking the patient to mark his pain level on the line between 1 and 10. The distance between 'no pain at all' and the mark that defines the subject's pain is measured. Zero represents 'no pain at all' whereas the ten represents 'the worst pain ever possible.' For the Sit to stand test, a folding chair without arms was used. The participant was seated in the middle of the chair, back straight; feet approximately a shoulder width apart and placed on the floor at an angle slightly back from the knees, with one foot slightly in front of the other to help maintain balance. Arms were crossed at the wrists and held against the chest. The participant was asked to stand from the chair as many times as possible. The test was demonstrated once, the task both slowly and quickly. The patient was given a practice repetition or two before completing the test. The participant was encouraged to complete as many full stands as possible within 30 seconds. The participant was also instructed to fully sit between each stand. While monitoring the participant's performance to ensure proper form, the tester silently counted the completion of each correct stand. The score is the total number of stands within 30 seconds. For the measurement of Timed up and go test, the patient started in a seated position. The patient was asked to stand up upon the therapist's command: walk 3 meters, turn around, walk back to the chair and sit down. The time stops when the patient was seated and was noted.

Conventional exercises were given to all patients as follows. Quadriceps Drills were given as conventional exercises as below.

1. Ankle-toe movements (ATM):- In this patient lies in a supine position and does active dorsiflexion and plantar flexion of the ankle. 7 repetitions were done.
2. Static Quadriceps Exercise (SQE):- In this patient lies in a supine position and a sand bag or a towel rolled under the knee. Ask the patient to push the knee down into a towel or sand bag. Put the fingers on the thigh to feel the quadriceps muscle tighten during contraction. Hold for 5 seconds and repeat it for 7 times.
3. Straight leg raising (SLR):- In this patient lies in supine and then raises the affected leg in hip flexion with knee extension while the other leg is flexed at knee. Hold the position for 5 second and then slowly put the leg down. 7 repetitions were done.
4. Last degree knee extension (LDE):- In this patient lies in supine position and with the help of the last degree extension board ask the patient to do an active knee extension. Hold for 5 seconds. 7 repetitions were done.
5. Prone knee bending:- In this patient lies in a prone position and ask the patient to flex the knee. Hold for 5 seconds and repeat for 7 times.
6. High sitting knee extension (HSE):- In this patient is in sitting position and ask patient to extend the knee with back straight. Hold for 5 seconds and repeat for 7 times.

All the subjects were given hotpacks to the affected knee for 20 minutes. Subjects were given treatment for 5 days daily and assessment was taken again on day 5.

Level of significance was kept at 5%. SPSS version 17 was used for data analysis

## Results:-

Numerical pain rating scale (NPRS), Sit To Stand (STS) and Timed To Get up (TUG) tests were used to assess the effect of Ultrasound (US) and Light Amplification by Stimulated Emission Of Radiation (LASER) in subjects with osteoarthritis of knee.

Total 21 subjects completed this study. Table 1 shows data of patients regarding age and gender. Table 2 shows mean values of outcome measures of all subjects on day 1. Wilcoxon test was used to find the difference in means within the group. Table 3 shows the mean difference in outcomes in group A (Ultrasound) at the end of 5 days. Table 4 shows the mean difference in outcomes in group B taking LASER treatment. Table 5 shows the mean difference in outcomes in group C taking hot packs and exercise. Table 6 shows the difference in mean of outcome measures between the groups using Kruskal-wallis test.

**Table 1:-** Demographic data of subjects.

MEAN	Total subjects	Group A	Group B	Group C
Number of subjects	21	7	7	7
Age (years)	58.7 +5.4	57+5.32	59.7+5.2	59.4+6.1
Gender M/F	9/12	3/4	3/4	3/4

**Table 2:-** Mean values of outcome measures of all subjects on day 1.

Outcome Measure	Group A	Group B	Group C
NPRS	4.6±1.1	4.6±0.8	5.1±1.2
SIT TO STAND	6.7±0.9	7.7±0.5	7.3±0.8
TUG (s)	11.1±1.9	9.9±2.2	10.5±0.9

**Table 3:-** Mean difference in outcomes in group A.

	PRE-1 MEAN±SD	POST-5 MEAN±SD	W-VALUE	p-VALUE
NPRS	4.6±1.1	3±0.5	-2.414	0.016
SIT TO STAND	6.7±0.9	8.7±1.2	-2.392	0.017
TUG (s)	11.1±1.9	9.3±1.7	-2.366	0.018

**Table 4:-** Mean difference in outcomes in group B.

	PRE-1 MEAN±SD	POST-5 MEAN±SD	W-VALUE	p-VALUE
NPRS	4.6±0.8	1.8±0.7	-2.460	0.014
SIT TO STAND	7.7±0.5	10.0±1.1	-2.392	0.017
TUG	9.9±2.2	7.6±1.3	-2.371	0.018

**Table 5:-** Mean difference in outcomes in group C.

	PRE-1 MEAN±SD	POST-5 MEAN±SD	W-VALUE	p-VALUE
NPRS	5.1±1.2	3.3±0.7SS	-2.392	0.017
SIT TO STAND	7.3±0.8	8.7±0.1	-2.428	0.015
TUG	10.5±0.9	9.00±0.7	-2.375	0.018

**Table 6:-** Mean difference in outcome measures between groups.

Outcome Measure	KW	p
NPRS	6.612	0.037
SIT TO STAND	3.020	0.221
TUG (s)	7.822	0.020

Applying Bonferroni's post hoc test mean difference in pain between group A and B was statistically significant ( $p=0.03$ ), and mean difference in TUG between group Band C was statistically significant ( $p=0.013$ ).

## Discussion:-

The present study was conducted to see the difference in effect of LASER and ultrasound in subjects with osteoarthritis and conventional physiotherapy. There was a statistically significant difference seen in participants given both LASER and ultrasound at the end of 5 days in all outcome measures. There was also a statistically significant difference seen in the subjects given hot packs and quadriceps exercises in pain, sit to stand and TUG. Between the groups statistically significant difference was seen in the timed up and go test and pain.

Group A which was given Ultrasound, showed that pain was reduced ( $W=-2.414$ ,  $p=0.016$ ), function improved STS ( $W=-2.392$ ,  $p=0.017$ ), and mobility improved, TUG( $W=2.366$ , $p=0.018$ ).The results are similar to findings of Ravanbod et al. [12] showed that US (pulsed mode, 1/9 duty cycle, 1 MHz, 0.4 W/cm<sup>2</sup> and 150 s) was more effective than LLLT (880 nm, 25 mW, 1 J/cm<sup>2</sup>), in reducing joint swelling and articular joint friction. Pulsed US stimulates cartilage repair and promotes anti-inflammatory and analgesic responses without predominant thermal effect. Similarly in the present study regarding an increased temperature, the absorption of the ultrasonic vibrational energy by the human body promotes molecular oscillations, producing heat and leading to therapeutic effects.<sup>[13]</sup> The thermal effects of the US include increased metabolic activity and blood flow, a reduction in subacute and chronic inflammation and muscle spasm, as well as a momentary increase in the extensibility of collagenous structures (e.g., tendons, ligaments and joint capsules) and contracture of connective tissue. The analgesic action may be caused by increased microvascular permeability and cell metabolism, enhancement of fibrous connective tissue extensibility and pain threshold elevation by thermodynamic mechanisms.<sup>[14]</sup> Stimulation of thermoreceptors and mechanoreceptors may help to reduce pain and swelling through a counter-irritation effect and the gate control.

Group B given LASER showed that the pain was reduced ( $W=-2.460$ ,  $p=0.014$ ), function was improved, STS ( $W=-2.392$ ,  $p=0.017$ ), and mobility was better, TUG ( $W=-2.371$ ,  $p=0.018$ ). The present study showed that LASER along with hot packs and quadriceps exercises was effective in reducing pain and improving sit to stand counts and improving mobility in the TUG test. The findings are similar to Rayegani et al.<sup>[15]</sup>, Sabbahi<sup>[16]</sup>. In vitro cell studies have demonstrated short term activation of the electron transport chain, increased ATP synthesis and reduction of cellular pH with application of therapeutic Laser. It has also been proposed that low level laser radiation can initiate reaction at cell membrane level, via photophysical effects of calcium channels. These biochemical and cell membrane changes are believed to cause the increase in macrophage, fibroblast and lymphocyte activity which are thought as the basis for the clinical benefits of laser. Certain authors also claim the vasodilating property of laser which can improve regeneration.<sup>[17]</sup>

Control group C showed improvements in NPRS ( $W=-2.392$ ,  $p=0.017$ ), STS ( $W=-2.428$ ,  $p=0.015$ ), TUG ( $W=-2.375$ ,  $p=0.018$ ). Heat is relaxing. Stiff, tense, and sore muscles can be relaxed and relieved with a little heat, and joints affected by arthritis pain are no different. Not only does heat relax muscles, it also stimulates blood flow and improves circulation, helps increase range of motion, and reduces stiffness in painful joints. When blood vessels get bigger this allows more blood, oxygen, and nutrients to be delivered to the injured tissues. Better circulation means more relaxation for those stiff muscles and joints.<sup>[18]</sup>

The present study showed that there is a difference in effect between LASER and US in reducing pain. In our study we can see that LASER is more effective in reducing pain than Ultrasound. Applying Kruskal-Wallis test, mean difference between the groups, for pain ( $KW=6.612$ ,  $p=0.037$ ), STS ( $KW=3.020$ ,  $p=0.221$ ) and TUG ( $KW=7.822$ ,  $p=0.020$ ). Applying Bonferroni's post hoc test mean difference in pain between groups A and B was statistically significant ( $p=0.03$ ), and mean difference in TUG between groups B and C was statistically significant ( $p=0.013$ ). The effects of laser and exercise on outcomes for patients with painful osteoarthritis of knee, showed better improvement in laser treated group as compared to control. It is proposed that, improvements in arthritic conditions are the results of reduced inflammation due to changes in the activity of inflammatory mediators, or the result of reduced pain due to changes in nerve conduction. Similar to present study, Rayegani et al. [15] showed that LASER given with 6 J/point for 3 min 20sec is more than effective than US with a dose of 1 MHz, Pulsed 1:1, 1.5W/cm<sup>2</sup>, for 5 min to reduce pain, joint stiffness and disability. In this study, it can be observed that LASER with high power and energy also lead to better results. Santamanto et al. found greater effects of HILT than ultrasound in the treatment of shoulder subacromial impingement. It has also been shown in Hsieh et al. study that LASER was superior to ultrasound in the treatment of patients with KOA which is in line with our findings, though LLLT was applied in their study. Sabbahi had concluded that the analgesic and anti-inflammatory effects of LASER are far greater and more durable compared to ultrasound effects.<sup>[16]</sup>

The study was carried out for a short duration. But it can be seen that LASER, ultrasound and conventional physiotherapy can be used effectively to reduce pain and improve function and mobility in subjects with osteoarthritis of the knee. In the future, studies using various doses for ultrasound or LASER can be carried out. Also studies to see the long term effects of these modalities can be done.

### Conclusion:-

Ultrasound, LASER and conventional physiotherapy are effective in reducing pain and improving function in subjects with OA knee. LASER is more effective than ultrasound for improving pain and better than conventional physiotherapy for improving function.

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None.

### Declaration of interest:

Authors declare no conflict of interest.

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